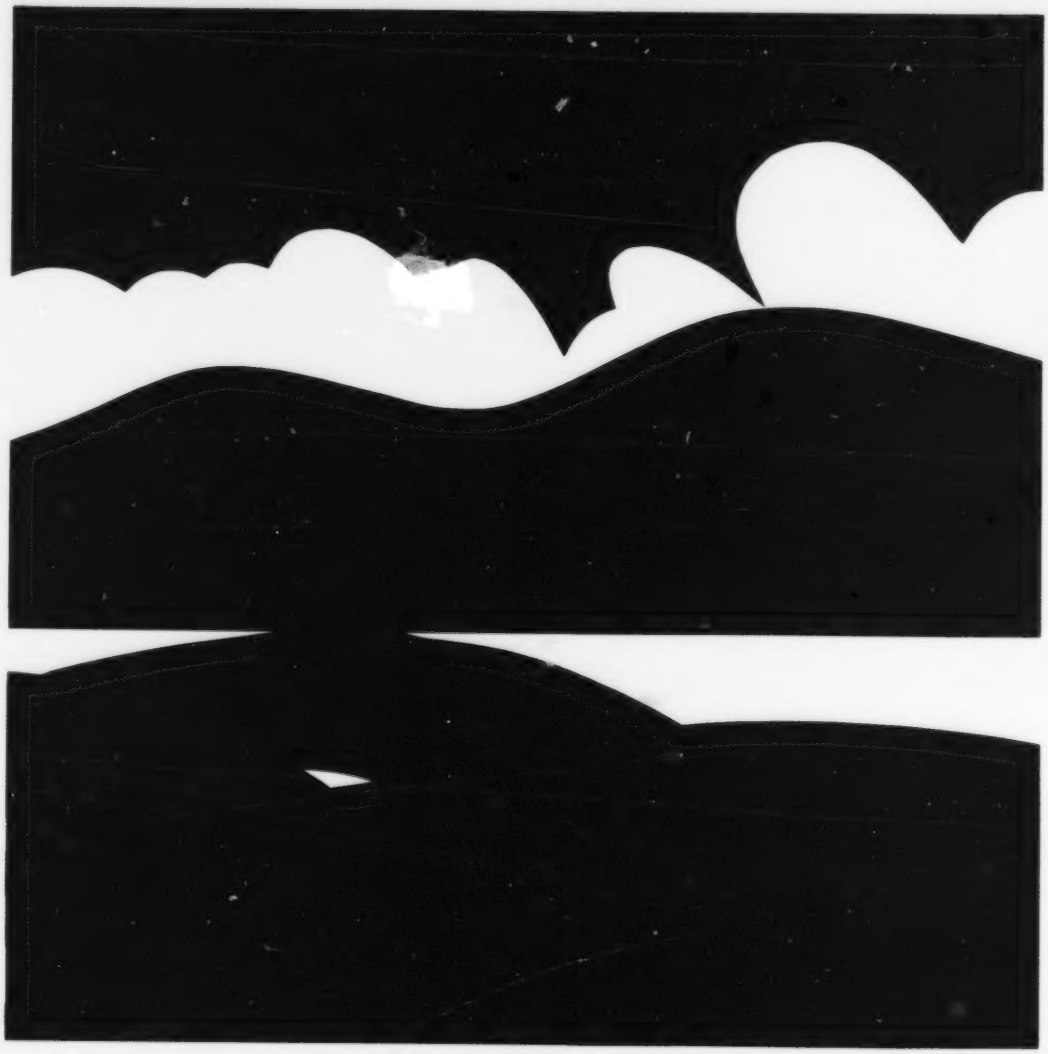
GARNER LAKE



Alberta

ENVIRONMENT
Water Quality Control Branch
Pollution Control Division

89-06100/

Lakes attract people. And people want to know why "their" lake is the way it is — why is it so green in July? Is the water quality really deteriorating? How do our activities affect the lake?

This brochure, one of a series on Alberta's lakes, attempts to answer these questions by presenting findings of water quality studies conducted by the Water Quality Control Branch of Alberta Environment.

As you read through the brochure, you may find you have questions about the concepts and illustrations. At the end is a section called **Explanation of Lake Characteristics.** Refer to this for further interpretation.

Brochures are available for the following lakes:

Sandy Lake	Pine Lake	Lac La Biche
Lac La Nonne	Garner Lake	Nakamun Lake
Wizard Lake	Skeleton Lake	Wabamun Lake

MARCH, 1985

Garner Lake is located in Alberta's lakeland, northeast of Edmonton. It is situated 5 km north of highway 28 near Spedden. Garner is a popular lake, with a provincial park and more than 150 developed lots. There is excellent public boat access at the provincial park.

As the depth contour map shows, Garner is triangular, with the deepest area (15 m or 45 feet) approximately in the center. The lake has no outflow. The few inlet creeks flow only during spring runoff or summer rains.

Perch, Pike, and Walleye inhabit the lake. It is not commercially fished.

The watershed or drainage area surrounding Garner Lake is small relative to the volume of the lake (drainage area/lake volume). This means that Garner Lake should have good water quality since the area of land supplying nutrients is relatively small. However, more than half of the drainage area is in agriculture or is used for park or cottage development. These land uses contribute more nutrients to the lake than land that is in natural bush, especially since much of the agricultural area is adjacent to the lake. Thus, Garner Lake is subject to occasional blue-green algal blooms or has heavy growth of filamentous algae, which forms floating mats in mid-summer.

You might believe, as many people do, that sewage from cottages is the main cause of water quality problems in Garner Lake. But even if we assume that every cottage contributes sewage directly to the lake — which is certainly **not** the case — the sewage contributions of phosphorus would only represent 9% of the total phosphorus supply (see Theoretical Phosphorus Supply table). As the table shows, the remainder comes from the land surrounding the lake, and from rain, dust, and snow falling on the surface.

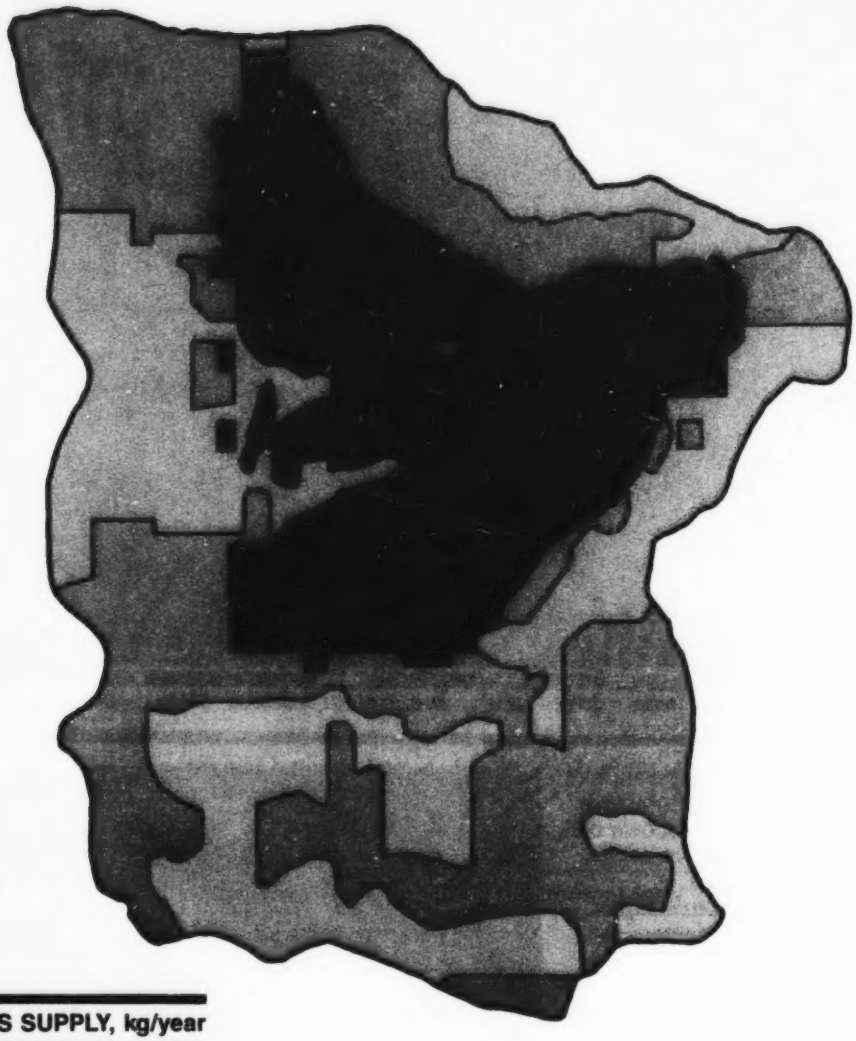
Depth Contour Map

LEGEND

—4— Depths in metres

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS		
LAKE AREA	km^2	7.09
DRAINAGE AREA (excluding lake)	km^2	25.26
DRAINAGE AREA/ LAKE VOLUME		0.5
VOLUME	m^3	50.63×10^6
MAXIMUM DEPTH	m	15.
MEAN DEPTH	m	7.14
INFLOW	m^3	4.61×10^6
RESIDENCE TIME	years	11.

Garner Lake Watershed Map



Forested/Bush

Cottage/Urban

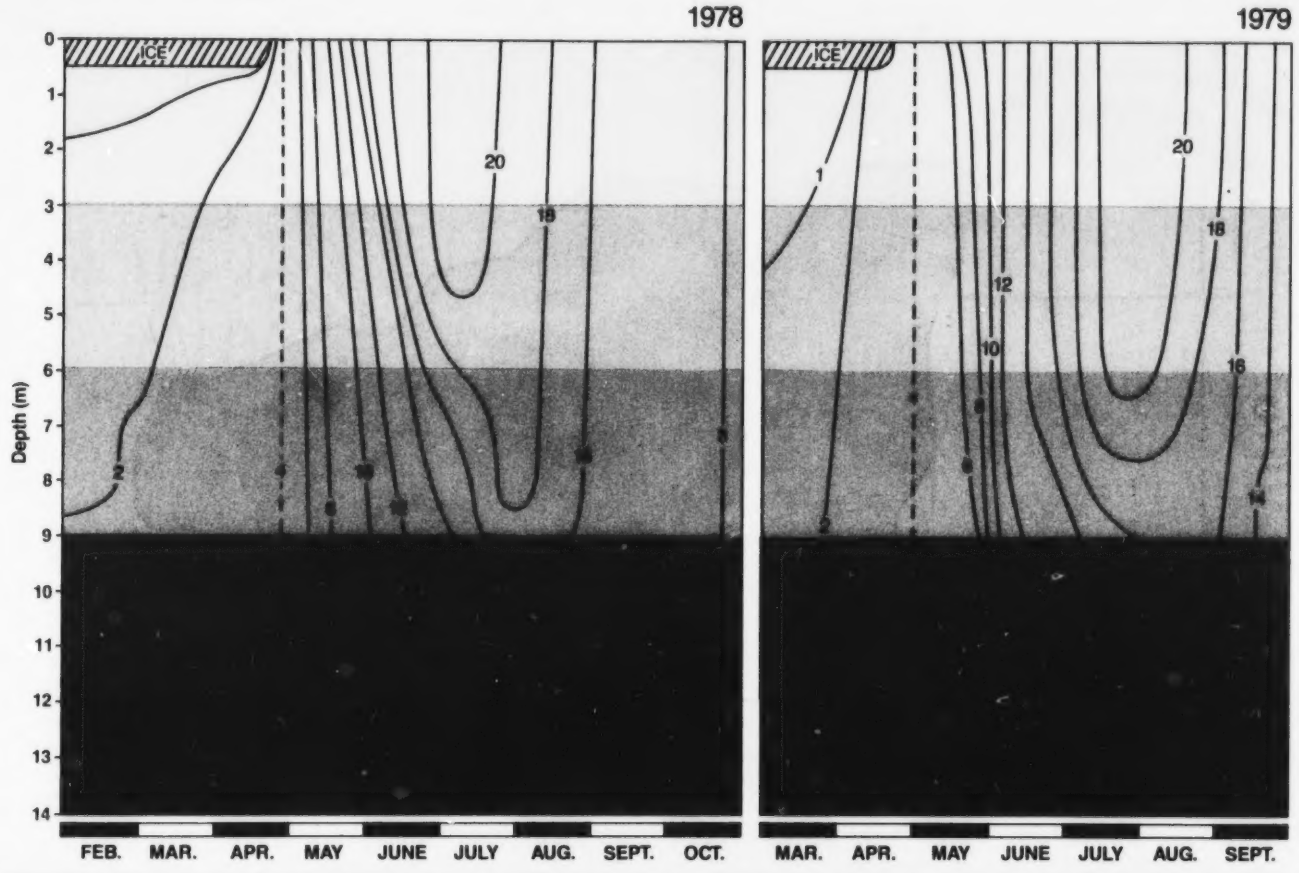
Agricultural/Cleared

0 1 2 km

THEORETICAL PHOSPHORUS SUPPLY, kg/year

Surface Run-off:	
ForestedBush	100.
Cleared/ Agricultural	679.
Urban/Cottages	159.
Precipitation, Dustfall	235.
Sewage from all cottages and camps	111.
TOTAL	1,284.
Areal loading, g/m² of lake surface	0.181

Temperature (°C)

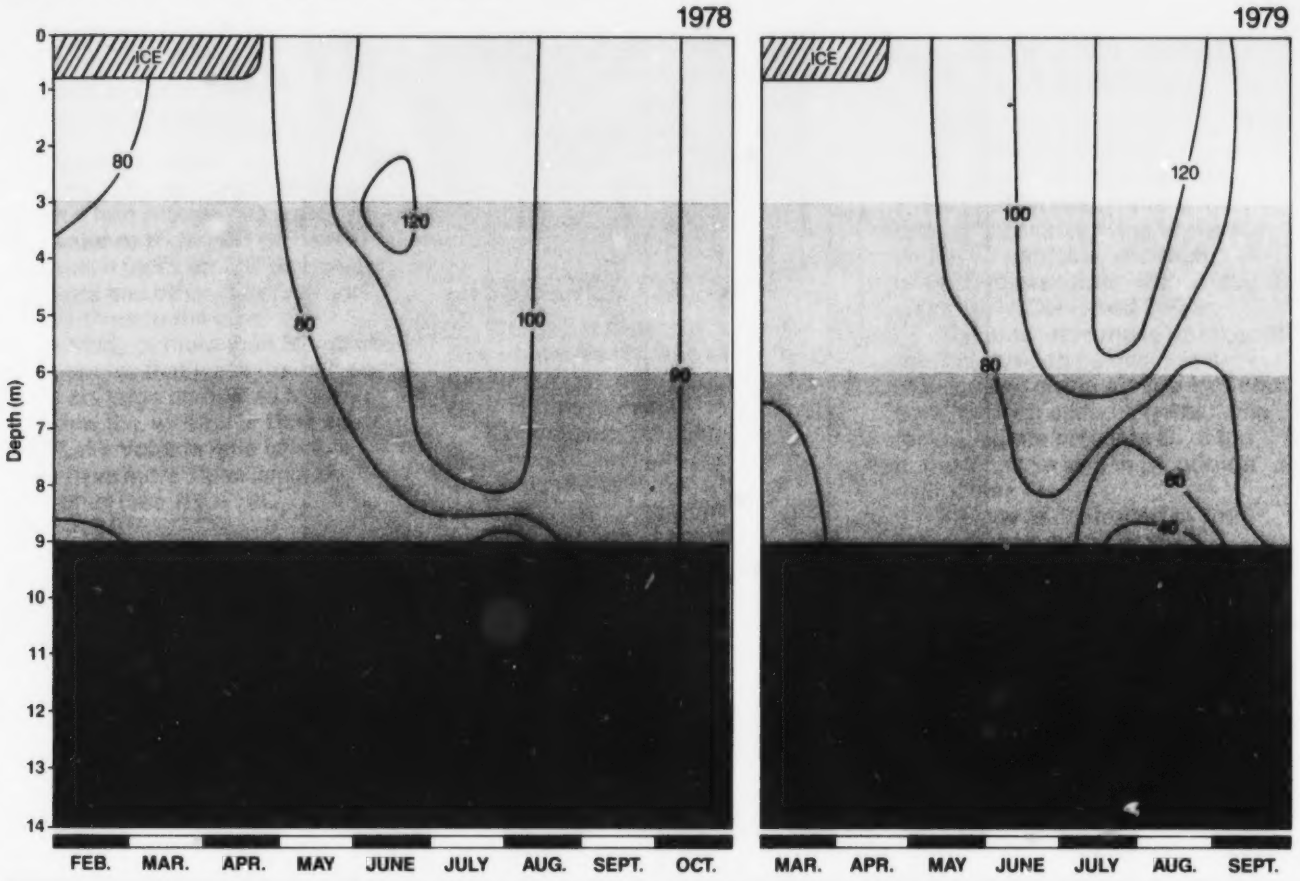


Garner Lake forms temperature layers in the deepest part of the lake in July and August. This is shown on the temperature graph above as looped lines.

When these temperature layers form, the water near the bottom is resistant to mixing from wind action. As tiny plants and animals die and sink to the bottom, these decay and use up oxygen. The dissolved oxygen graph shows this depletion. In July and August of 1978 and 1979, oxygen saturation was less than 20% below a depth of about 20 metres.

See "EXPLANATION OF LAKE CHARACTERISTICS" at end of brochure for clarification of these graphs.

Dissolved Oxygen (% Saturation)

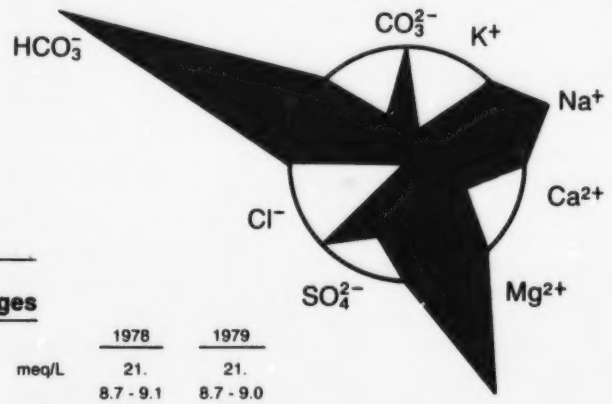


In the upper water in midsummer, oxygen was supersaturated (over 100%). This often happens when algae are growing rapidly. On bright warm days, the algae produce large quantities of oxygen which supersaturate the water.

In winter there appears to be an abundance of oxygen, so that winter fish kills are unlikely.

The Ionic Diagram shows that Garner Lake water is of a magnesium-bicarbonate type. Although most Alberta lakes have bicarbonate as a dominant ion, only a few have magnesium as the ion of secondary dominance. Garner is a closed lake, with a higher salinity than most lakes in the area. Magnesium tends to be a dominant ion in lakes of this type. In spite of its fairly high salinity, the water in Garner Lake is well within the range required by fish and other aquatic life.

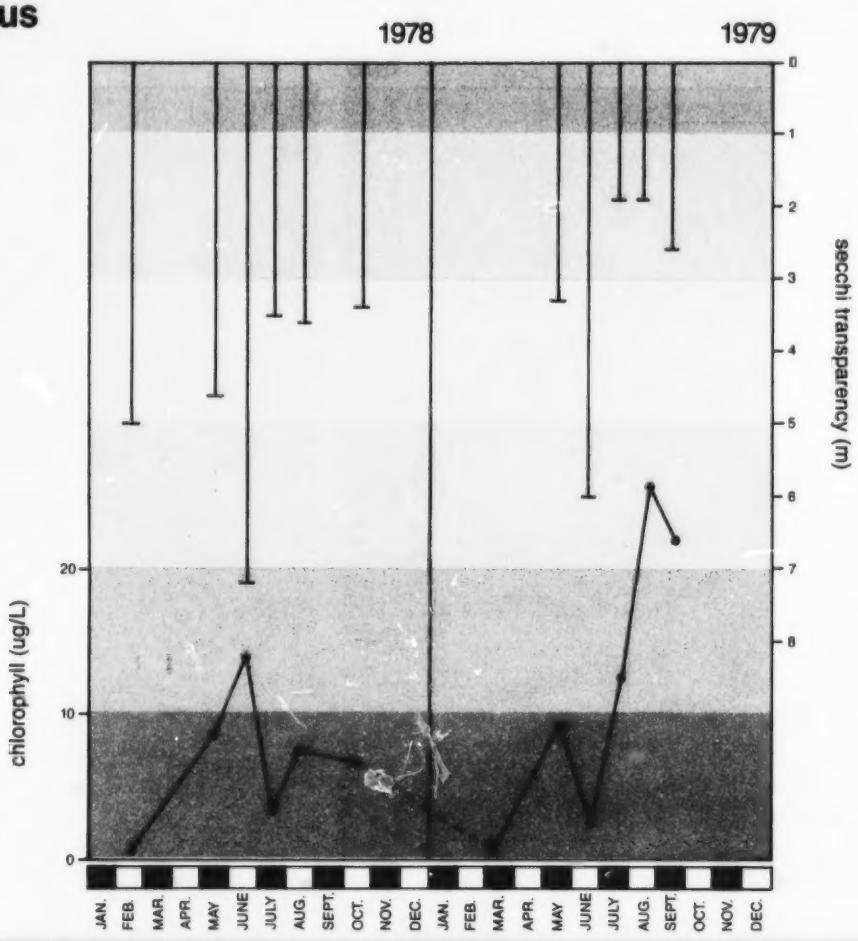
IONIC DIAGRAM — Relative proportions of Ions 1978-1979



CHEMISTRY — ice free season averages

		1978	1979
TOTAL SALINITY	meq/L	21.	21.
pH (RANGE)		8.7 - 9.1	8.7 - 9.0
ALKALINITY	mg/L	428.	427.
TOTAL DISSOLVED SOLIDS	mg/L	524.	525.

Trophic Status



Anyone who frequents Garner Lake regularly knows that in some years filamentous algae seems to threaten to take over the whole lake. This type of algae grows on the bottom or on aquatic plants. Eventually it rises to the surface, forming yellow mats that blow into bays. In other years, blue-green algae dominates — it forms green scums which decompose and coat rocks with blue paint-like material.

The 1978-79 study done by the Water Quality Control Branch was not designed to answer why this lake varies so much from year to year. But most of the differences listed in the Trophic Characteristics table are related to the abundance of the filamentous algae in shallow areas. When it is abundant, phosphorus and chlorophyll in the open water are low, and Secchi transparency is high, as in 1978. In fact the very clear water in June of 1978, as indicated by the long vertical line on the graph above, is nearly a record for the lakes the Branch has sampled.

It is difficult to assess the level of fertility in Garner Lake, because the filamentous algae cannot easily be measured. The 1979 phosphorus, chlorophyll, and Secchi transparency averages probably give a better picture of what Garner is like than those of 1978. In 1979, the lake would be called mildly eutrophic.

The lake has probably become more fertile in the past 50 years or so, because if all the land now in agriculture or cottage development could be converted back to natural bush, the phosphorus supply theoretically would be reduced by more than half. It is likely that the lake has more algae than it did before modern development.

TROPHIC CHARACTERISTICS — Ice-free season averages

		1978	1979
PHOSPHORUS	µg/L	37.	56.
NITROGEN	mg/L	2.05	1.60
CHLOROPHYLL	µg/L	7.8	14.7
SECCHI TRANSPARENCY	m	4.5	3.1

TOTAL NUMBER OF BENTHIC ORGANISMS	387/m²
Oligochaeta	0% of total
Chironomidae	44% of total

Explanation of Lake Characteristics

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Drainage Area or the watershed of a lake is the land surface from which a lake receives its water. As rain water or snowmelt gathers in streams, it picks up soil particles, nutrients and other materials and carries them to the lake.

A study of more than 30 Alberta lakes shows that when drainage areas are large compared to lake volumes, (i.e. when this **Drainage Area/Lake Volume** ratio is large), lakes have more algae (are more eutrophic) (see TROPHIC CHARACTERISTICS).

Mean Depth is the volume of the lake divided by the surface area. Shallow lakes are often more eutrophic than deeper lakes of a similar size.

Inflow is the total volume of water entering the lake in a year. It is related to **Residence Time,** which indicates the time it would take the inflow to completely fill an empty lake.

TEMPERATURE

Alberta lakes show two basic annual patterns of temperature distribution through the water.

Deep lakes, or those protected from strong winds, form layers with the coldest water near the bottom. Because this colder water is denser, it resists mixing into the warmer, lighter upper layer.

For much of the summer, the bottom portion of water is isolated from the top portion. In spring and fall, these lakes usually mix from top to bottom from wind action as the water becomes uniform in temperature and density. In winter, under ice, the warmest water (about 4°) is on the bottom, because water is most dense at this temperature.

Shallow lakes mix throughout the summer or layer only temporarily. In winter, the temperature pattern of these lakes is similar to that of deep lakes.

The diagram(s) show temperature at each depth over the annual cycle. Similar temperatures over time are connected by lines called isotherms. Vertical lines indicate mixing, while horizontal lines indicate layering.

DISSOLVED OXYGEN

Oxygen is essential to the life in lakes. It enters the lake water from the air through wind action, and plant photosynthesis.

Oxygen is consumed by respiration of animals and plants, including the decomposition of dead organisms by bacteria. A great deal can be learned about the "health" of a lake by studying its patterns and quantity of oxygen.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more eutrophic, and increasing quantities of plants and animals respire and decay, the balance shifts toward consumption — especially near the lake bottom where dead organisms accumulate.

In deep productive lakes (see TEMPERATURE), the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (Fish are stressed when oxygen falls below about 20% saturation — shown in red on the diagram). Fish kills occur when decomposing or respiring algal populations use up the oxygen. In summer, this usually happens during an algal bloom on calm nights.

The diagram shows oxygen saturation at each depth over the annual cycle. Similar saturations over time are connected by lines called isopleths. Vertical lines indicate uniform saturation from top to bottom, while horizontal lines indicate stagnation near the bottom.

SALINITY AND TOTAL DISSOLVED SOLIDS

Lake water contains a multitude of dissolved substances. These can be seen by allowing a dish of lake water to evaporate. If the water is filtered to remove living organisms and other particles, and then allowed to evaporate, the residue is called **Total Dissolved Solids.**

The ions* that make up most of this residue can be measured individually, giving a value for **Total Salinity** when added together. The **Ionic Diagram** presents all of the major ions in a lake in proportion to each other.

Salinity is controlled by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. Lakes of high salinity, such as many of those found in southeastern Alberta, have fewer species of plants and animals than freshwater lakes; many are too saline to support fish.

*Ions: Chemical form in water of constituents such as sodium and carbonate.

PH AND ALKALINITY

The pH of lake water refers to its concentration of hydrogen ions on a scale that runs from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral — neither acidic nor alkaline.

Most Alberta lakes fall between pH 6 to 9, with the majority on the alkaline side. **Alkalinity** refers to the capacity of water to neutralize an acid, and is a measure of the alkaline materials present in the water.

Alberta lakes that were formed in sedimentary bedrock have a large capacity to neutralize acids entering them, such as from acid rain.

TROPHIC CHARACTERISTICS

The word "trophic" literally means nourishment.

Mountain lakes usually are "poorly nourished" or **oligotrophic.** Levels of nutrients such as phosphorus and nitrogen are low, plant life is sparse, and the water is clear. Fish production is low.

On the other end of the scale are well-nourished or fertile lakes called **eutrophic.** In these lakes, aquatic plants, including tiny suspended algae, flourish because the water contains abundant nutrients.

Mesotrophic lakes, those intermediate in fertility, often combine the best features of the other two types.

In some lakes, the nutrient supply is so high that plant growth inhibits the recreational use of the lake. Lake users consider such a lake to have poor water quality. One of the purposes in studying lakes is to determine whether fertility is increasing.

There are several ways to measure a lake's fertility or **Trophic Status.**

Phosphorus and **nitrogen** can be measured directly. Phosphorus in lakes of the Boreal Forest/ Parkland areas of Alberta range between 10 and 120 ug/L, or oligotrophic to highly eutrophic, and nitrogen ranges between 0.5 and 3.5 mg/L.

Transparency declines as a lake becomes more fertile. It is measured with a black and white plate called a **Secchi Disc,** which is lowered through the water on a line marked at metre intervals. The depth at which it can no longer be seen is the Secchi transparency.

The quantity of algae in the water can be determined by measuring its content of **Chlorophyll,** the green photosynthetic pigment.

The number of animals living in the bottom mud of the lake also may indicate its fertility. **Oligochaeta** are tiny worms; **Chironomidae** are immature stages of a fly called a midge.

THEORETICAL PHOSPHORUS SUPPLY

Lake scientists know that for most lakes, the amount of algae in the water is related directly to the amount of phosphorus. This is because phosphorus is usually in shortest supply of all the nutrients that lake plants need. When it runs out, the algal population can no longer increase. A larger phosphorus supply usually results in more algae.

Based on studies from all over North American, the quantity of phosphorus contributed by a hectare of forest is remarkably similar no matter where the lake is located. Similarly, agricultural or cleared land overlying sedimentary bedrock contributes fairly similar quantities of phosphorus per hectare in most lake watersheds. This was confirmed for Alberta by measuring quantities of phosphorus supplied by various land uses in the Baptiste Lake watershed.

In all studies, the phosphorus supply from cleared or agricultural land was greater than that from forest, averaging 5 times more.

The "theoretical" phosphorus supply is estimated, without actually measuring it, by multiplying phosphorus supply factors for each type of land use by the area of that land use.

Similar factors are used for the supply from precipitation. The supply from sewage assumes that all sewage enters the lake, since it is nearly impossible to measure this source in lakes. Therefore, the number reported represents the maximum possible supply from that source.

It might be expected that a large phosphorus supply would produce a eutrophic lake. But the size of the lake is also important. If the total phosphorus supply is divided by the surface area of the lake, the resulting **Areal Loading** figure can be compared with other lakes, and can be used as an indication of trophic status.